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Scalar wormholes in a cosmological setting and their instability

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Abstract

We construct exact nonstatic nonhomogeneous spherically symmetric solutions in the theory of gravity with a scalar field possessing the exponential potential. The solution of particular interest corresponds to the scalar field with negative kinetic energy, i.e. a ghost, and represents two asymptotically homogeneous spatially flat universes connected by a throat. We interpret this solution as a wormhole in the cosmological setting. Both the universes and the wormhole throat are simultaneously expanding with acceleration. The character of expansion qualitatively depends on the wormhole's mass m. For m=0 the expansion goes exponentially, so that the corresponding spacetime configuration represents two de Sitter universes joining by the throat. For m>0 the expansion has the power character, so that one has the inflating wormhole connecting two homogeneous spatially flat universes expanding according to the power law into the final singularity. The stability analysis of the nonstatic wormholes reveals their instability against linear spherically symmetric perturbations.

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